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(54) **Optical memory recording disc**

(57) An erasable optical memory recording disc utilising a controllably variable pulsed laser to write, read and erase contrast intensified micro-miniature deformations in the recording disc material 5, such deformations being produced by spot melting of a wax type coating on a contrast intensifying substrate or a wax coating incorporating a contrast intensifying agent and being readable and erasable at other predetermined levels of laser emission to the level of recording data onto the disc. Wax based materials may be coloured, translucent, transparent, or opaque. Reflecting facilities may be a heat resistant disc lining and of silver metallised film or coloured plastic film. Ignition may be prevented by an inert gas in gaps 8, 9. A chromatic polarising agent may be used, and an optical grating may magnify guide tracks. Other optically induced variations of the recording material are specified.

FIG. 1

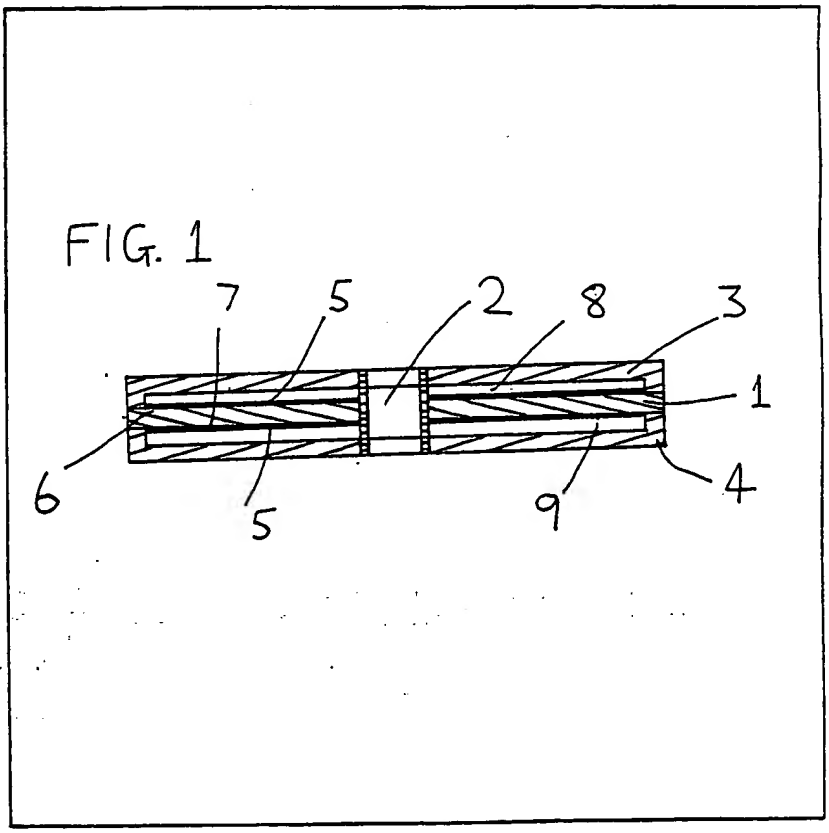

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FIG. 1

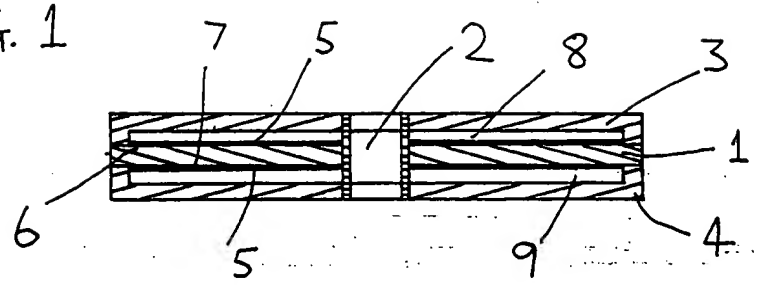

FIG. 2

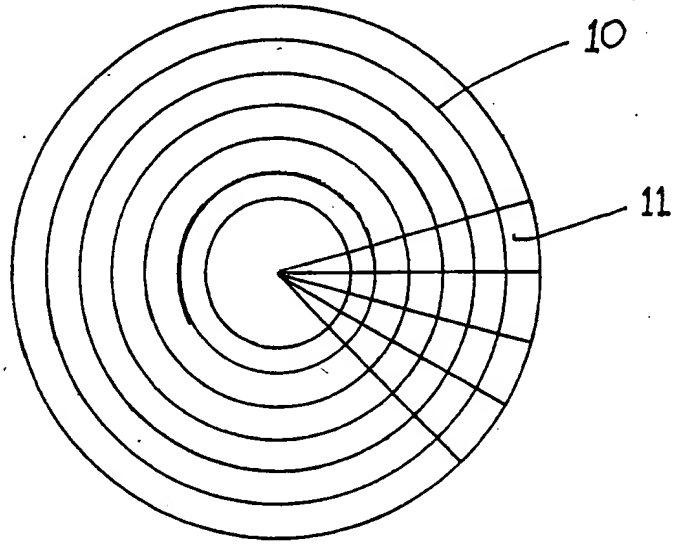

FIG. 3

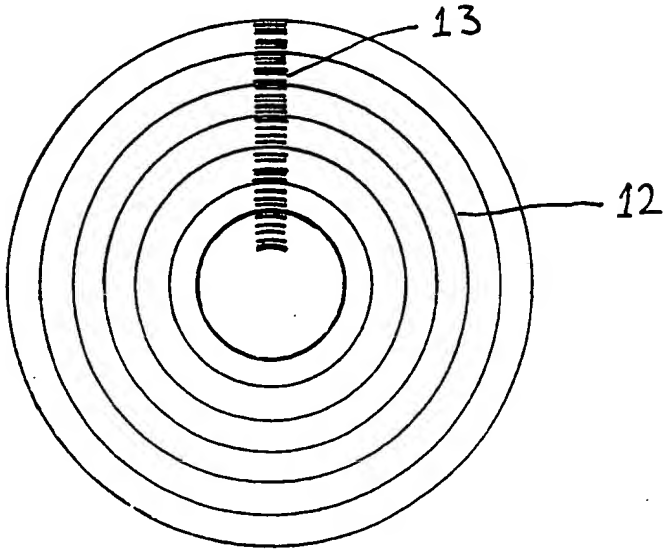

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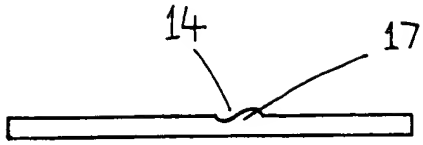
FIG. 4



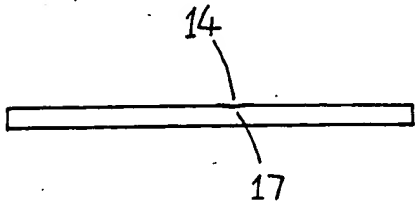
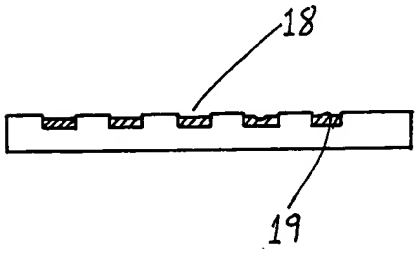


FIG. 5

FIG. 6



SPECIFICATION

Erasable optical memory disc

This invention relates to an erasable optical memory recording disc on which, by pulsed laser means, data may be recorded as a series of micro-miniature deformations of the disc recording material surface and may be optically sensed as a binary code of high or low light levels (or vice versa) reflected from the surface and the surface deformations respectively and to methods by which such erasable discs may be manufactured.

The disc, and variants of the basic disc embodying the erasable recording material technique described herein, may be used to considerable advantage as mass data storage means for computers and data, image and sound recording and reproduction machines or systems.

Hitherto, video discs and optical memory discs have not been erasable once data has been loaded or stored on the disc and consequently have been confined in use to providing permanent records and fixed read only memories.

An object of the present invention is to provide an optical memory disc which may be erased and re-recorded on as often as desired and thereby, in overcoming the limitation of presently available optical discs, provides the far more powerful optical equivalent of conventional magnetic disc memories. Computers could thus benefit from having a massive random access and true optical read/write memory of a compact size impossible with conventional magnetic disc memories. Video disc recorders and players would also benefit from a disc that may be repeatedly erased and recorded afresh at will.

Variants of the basic disc include single sided discs; double sided discs; multiple platter discs arranged in stacks on a spindle with space between each disc; discs to which data may be written and read from in a sequential access mode or random access mode according to the desired mode of use or to the operating mode of the device in which said disc is used or in any desired combination of such variations. Thus, for example, a double sided disc may have one side specifically arranged to provide for sequential access of data and the other side arranged for random access of data. Alternatively, a general purpose disc may be provided permitting data to be recorded and retrieved by either random or sequential access modes.

According to the basic concept and principle technique of this invention the essential requirement for making an erasable optical memory disc or video disc is the provision of, upon or within a carrier substrate, a layer of suitable recording material capable of adopting either one of two discrete or contrasting states such as solid or liquid; hard or soft; light or dark; smooth or rough; bright or dim; deep or shallow; raised or lowered; flat or raised; flat or depressed etc. and which paired state may be readily transformed from the first state to the second state of the said material by the impinging thereon of a pulsed beam of a controllably variable intensity laser. At one intensity of the pulsed laser emission a micro-miniature deformation may be created in the recording material surface; at another level of intensity the date bit represented by the deformation may be optically read non-destructively; and at another level of intensity the data may be erased, that is returned to its original unrecorded state or to a state sufficiently close to the original state as to be unmistakably distinguishable from a recorded data bit, the respective laser pulse intensities and pulse durations and widths to achieve said results being pre-determined in relation to the recording material used and/or the direction and speed of rotation of the disc.

Thus according to the present invention there is provided optical disc means having one or more flat surfaces forming, or on which may be formed, a carrier substrate upon which is deposited a layer of suitable dual state recording material variably sensitive to the effect of a laser beam impinging thereon.

Various substances of differing consistencies may be compounded to produce the required recording material conforming to the above specification. As preferred, however, the recording material is a coating of wax, or a wax based or resinous compound, or wax type material, or alternatively, may be any suitable dual state material having the characteristics of wax, which, by being sensitive to heat, is thus capable of being spot melted by the pulsed laser when said laser is applied at the appropriate intensity to form, on solidifying, a deformation of the material representing an optically readable data bit that remains stable until erased.

Depending on the consistency of the wax recording material and the direction, intensity and duration of the pulsed laser beam the deformations created in the recording material may be formed as minute ridged craters, holes, depressions, mounds, bubbles or trenches of shallow or deep depth any of which deformations may be erased by remelting the recording material at that data location to return the material to its original level state. Preferably, the wax coating consistency is such that the wax melts and resets rapidly and is sufficiently hard when set that no displacement of data can occur due to the centrifugal force exerted on it by the rotation of the disc, for example sealing wax such as is used to seal envelopes being an ideal standard. Since disc rotation speed may be relatively slow, various other consistencies of wax may also be used. The wax based materials may also be coloured, translucent, transparent or opaque to provide, in conjunction with various possible reflecting means aids, appropriate binary codes of light levels of reflection.

Reflecting means aids are preferably provided in the form of a heat resistant disc lining and may be composed of silver metalised film or coloured plastic film on which the recording material may be deposited. In accordance with the principle of

this invention said film is chosen t be of a contrasting colour to the rec rding material, such that for example a light coloured wax is d p sited on a dark coloured reflective lining or a dark coloured wax is deposited on a light coloured reflective lining. In this way, deformation in the recording material resulting in say a well or crater will alter the light intensity reflected from the bottom of the well or crater compared with that of level wax, according to the colour of the wax and the reflecting means aid such that said reflection may be of greater or lesser intensity to that reflected from the flat recording material. Alternatively, the reflective lining may be positioned on the opposite side of the carrier substrate.

The disc comprising or holding the carrier substrate is preferably formed around a centre hub and housed within a protective enclosure shaped like an inverted shallow flat bottomed dish with a centre opening for the hub. The entire assembly may be made of any suitable heat resistant transparent plastics material or optical quality, double sided discs being formed either as two single discs sandwiched back-to-back or as one disc sandwiched between two protective enclosures. Various methods of coating the carrier substrate with the waxed recording material may be used including spraying or evaporating molten wax onto the carrier or simply melting a predetermined quantity of wax to provide the required thickness of coating, spinning it in a centrifuge and allowing the wax to cool and set level evenly over the substrate.

To prevent the possibility of the recording material igniting when heated by the laser an inert gas such as argon may be introduced during manufacture to replace the air gap between the recording material and the disc cap. It will be appreciated that in some circumstances it may be desired to erase the entire content of the disc and this may be effected by the simple expedient of gently heating the disc in an oven and allowing the molten wax to cool and set in a level orientation.

In an alternative embodiment of the present invention the recording material compound is preferably transparent or translucent and contains a chromatic polarising agent such as is used in sunglasses which automatically darken in response to increased light intensities falling thereon. In this embodiment the rotation or change in the polarisation of the chromatic material from light to dark in response to the laser pulse at recording intensity impinging thereon may be "locked" or sealed into the wax recording material as it resets solid again and is thus stored as a dark area on the disc surface until it is released or erased by further remelting. Thus more than one dual state material may be c mbined to form the recording material surface, one encapsulating the other.

Data, laser written t the recording material surface of the disc, is preferably recorded in an arrangement of addressable concentric tracks, said tracks b ing divided int addressable sectors to fulfill either mode of random access and serial access of data. Alternatively, data may be applied in a continuous spiral track such as is used in conventional gramophone records to provide a purely serial access mode of data. Data may also be recorded in the form of arcuate bar codes.

In order to permit an optical read/write head system furnished with an optical grating employing the Moray effect, to locate a particular track, guide channels or tracks corresponding to the data storage tracks are preferably provided insitu to the disc during manufacture, said guides containing permanent pre-recorded addresses at regular intervals for track and sector identification. Guide channels may, by photographic mastering and duplicating techniques, be provided within the carrier substrate surface and be filled to an appropriate depth with the recording material, while guide tracks may be formed as a photographically produced image on the inner surface of the disc enclosure. The disc as a sealed unit thus provides protection for the recording material and guidance means. Alternatively, a guide channel may be provided by means of a second laser so positioned as to form a "furrow" beside each concentric data track. It will be appreciated that in the case of multiple stacked disc units only one side of one such disc need be provided with track and address guidance means to provide random access to any of the discs, as multiple read heads would be mounted on a common linear motor driven arm in fixed relationship to each other.

Data may be erased by bit, sector, track or in whole by the means described above. In addition, data may be copied from one disc to another. Alternatively data may be erased by laser pulses applied while the disc is rotated in the opposite direction to that in which data was written on the disc, in order to allow the recording material to collapse back into the data well caused by centrifugal forces exerted on the molten wax medium. Thus a preferred disc player/recorder would have a disc drive motor capable of spinning forwards and backwards.

The following description refers to the essential features and further optional features of the invention and to aid understanding reference is made to the accompanying drawings where these features are shown in preferred form. It is to be understood however, that the essential and optional features are not limited to the specific forms of these features as shown in the drawings.

Figure 1 is a cross section view of a double sided disc sealed between a sandwich construction of two protective enclosures in accordance with the present invention;

Figure 2 is a schematic illustration of a disc face viewed through its transparent protectiv enclosure;

Figur 3 is a schematic as in Figure 2 showing means of guidance for an optical sensor head;

Figure 4 is a schematic illustration of the rec rding material layer having a p rti n deformed into a raised data bit representati n;

Figure 5 is a schematic as in Figure 4 illustrating the erased data bit and

Figure 6 is a schematic cross section of the disc substrate.

Figure 1 illustrates a double sided disc substrate 1 having a centre hub 2 and housed within transparent protective enclosures 3 and 4 respectively, the required recording material 5 being deposited on both disc faces 6 and 7 as an even layer. Reflective aids means (not shown) may optionally be positioned between the disc substrate 1 and the recording material 5 to enhance the intensity and contrasts of reflected light levels from the disc surface. The air gaps 8 and 9 may optionally be filled with a suitable inert gas to prevent combustion of the recording material taking place.

Figure 2 illustrates the concept of organising the disc surface into concentric addressable data tracks 10 divided into addressable sectors 11. Data may be stored within said data tracks or if such tracks are used as pre-recorded guide channels within them or beside them.

Figure 3 illustrates permanent guide tracks or optionally guide channels 12 required to enable an optical read/write head system to randomly access a particular data track by reference to an optical grating, employing the Moiré effect to magnify the guide tracks or channels, contained in said head. A head positional reference scale in the form of concentric bar codes 13 is preferably permanently imaged on the inner surface of the disc enclosures to speed the access times of the optical read head in locating particular tracks approximately, permanent addresses (not shown) pre-recorded at intervals along such guides enabling exact location of data to be achieved thereafter. Guide channels are preferably formed by mastering and duplicating techniques in the disc carrier substrate 1 of Figure 1 while guide tracks are preferably imaged on the inner side of the disc enclosures 3 and 4 respectively of Figure 1.

Figure 4 illustrates a data "bit" 14 created by the interaction of the pulsed laser in melting a portion of the recording material and the centrifugal force of the rotating disc which tends to force the softened wax into a ridged depression or cavity 17.

Figure 5 illustrates the erasure of the data bit 14 of Figure 4 caused by the interaction of the pulsed laser in remelting the wax and the centrifugal force of the reversed direction of disc rotation which tends to force the ridge of wax to collapse back into and refill the cavity 17.

Figure 6 is a schematic enlarged cross section of the disc substrate and showing preformed optional guide channels 18 containing the wax recording material 19.

It is to be appr ciated that dimensions of rec rding material layer thicknesses and data bits stored therein may be f the rder f microns or less and thus data st rag is highly c ncentrated.

Thus has been described a disc and a simple method of making an erasable optical memory disc, which, by being erasable, greatly extends the versatility and power of optical data recording means.

CLAIMS

1. An erasable optical memory disc on which by pulsed laser means data may be recorded as a series of contrast intensified microminiature deformations of the disc recording material surface and be optically sensed by a suitable red head as a binary code or high or low light intensity levels reflected from the disc surface and surface material deformations respectively, the said recording material covering the disc substrate surface being combined with contrast intensifying reflecting means aids, and being capable of adopting one of two discrete and contrasting states and which paired states may be readily transformed from the first state to the second state and back from the second state to the first state by the impinging thereon of a pulsed beam of a controllably variable intensity laser.

2. A disc as in claim 1 whereby at one intensity of the pulsed laser emission a contrast intensified micro-miniature deformation is created in the recording material surface; at a second level of intensity the data bit represented by the deformation may be optically read non-destructively and at a third level of intensity of laser emission the data bit may be erased, that is restored to its original unrecorded state or to a state sufficiently close to the original state as to be unambiguously distinguishable from a recorded data bit, the respective intensities, widths and durations of the laser pulse emissions being pre-determined in relation to the recording material used and the direction and speed of rotation of the disc.

3. A disc as in claims 1 and 2 and comprising a rigid disc substrate carrying a suitable contrast intensifying heat resistant lining such as metalised silver or coloured plastic film on which is deposited an even layer of heat sensitive wax such as sealing wax or resin capable of being micro-spot melted by the pulsed laser when said laser is focussed at the appropriate intensity to form on rapid re-solidification a contrast intensified micro-miniature deformation of the recording material surface thereby providing an optically readable data bit that will remain stable until erased.

4. A disc as in claims 1, 2 and 3 wherein the contrast intensifying medium is chosen to be of a distinctively contrasting colour to that of the wax recording material and the wax recording material is chosen to be coloured, transparent, opaque or translucent according to the reflecting means aid used.

5. A disc as in preceding claims wherein the contrast intensifying means is a thermochromatic p larising agent encapsulated in a disc coating of translucent r transparent wax recording material such that a change, r tati n or rev rsal of the orientation of the polarisation of said agent in response to the laser pulse applied at recording intensity thereon may be "locked" or sealed into

the wax recording material as it rapidly sets hard, thereby being stored as a dark contrast intensified area on the disc surface until released and erased by further rem lting of the wax.

6. A disc as in preceding claims formed around a centre hub and housed within a protective shallow flat bottomed dish shaped enclosure having a centre opening for the hub, the air gap between disc and disc enclosure being evacuated or replaced by an inert gas, the sealed enclosure being moulded from any suitable heat resistant transparent plastics material of optical quality.

7. A disc as in preceding claims and having a magnifying ptical grating employing the Moiré effect t assist an optical read/write head system to locate a particular data track with reference to preformed guide channels, tracks or arcuate bar codes located on the disc enclosure or the disc surface.

8. A disc as in claim 7 in which guide tracks are formed on the surface of the disc by means of a second laser so focussed as to provide a furrow or track parallel to the recorded data.

9. An erasable optical memory disc substantially as herein described and with reference to the accompanying drawings.

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